INTEGRATED FILTER HOUSING WITH ASSOCIATED CLEANING SYSTEM AND METHOD

FIELD OF THE INVENTION

[1] The present invention relates generally to filter housings and, more particularly, relates to an integrated multi-round filter housing with associated systems and methods for cleaning the filter housing using Clean-in-Place (CIP) technology.

BACKGROUND

[2] Filter housings are widely used in a variety of applications in the pharmaceutical, food, fine chemical and water purity industries to filter or purify fluids. Processing pressures may typically range from less than 10 p.s.i. to approximately 1000 p.s.i., depending on the specific product being filtered. Traditionally, a filter housing includes a base assembly with a deep collection chamber, a cartridge plate with a plurality of longitudinal filter cartridges attached thereto, and a dome which fits over the top of the entire filter housing (*see generally*, **FIG. 1**). These elements are typically sealed against each other using a plurality of O-rings or other gasket-type sealing devices. A plurality of bolt assemblies are then used to compress the filter housing dome against the base assembly, thereby squeezing the two O-rings against the intermediate cartridge plate.

[3] This prior art design suffers from a variety of potential and actual problems. The prior art design contains an unacceptable number of constituent elements included in the filter housing. Many of these elements must be removed and cleaned separately after every production run, and the junctions or joints between each of these elements create areas that may include tiny crevices and cracks which may promote bacterial growth.

[4] Additionally, there are many horizontal surfaces in typical prior designs which promote the collection or "pooling" of both unfiltered product (on the upper face of the cartridge plate) and filtered product (on the lower face of the collection chamber). This pooling wastes both unfiltered and filtered product, and may promote bacterial growth. Also, certain pooled product may be toxic or otherwise harmful which may endanger the safety of an operator during filter housing assembly and disassembly.

[5] Finally, the orientation of the various elements of the prior art filter housings limit the ability to use an automated cleaning system, such as Clean-In-Place (CIP) technology. Automated cleaning of these prior art systems may necessitate the use of specialized additional adapters. Manual cleaning increases the time between production cycles, requires valuable manpower, and reduces the overall efficiency of the filtering system. Additionally, automated cleaning techniques may be more repeatable and accurate than manual systems, and may further be safer for operators when volatile chemicals are used in the cleaning process.

SUMMARY OF THE INVENTION

[6] The present invention relates generally to filter housings and, more particularly, relates to an integrated multi-round filter housing with associated systems and methods for cleaning the filter housing using Clean-in-Place (CIP) technology. The present invention generally includes an integrated filter housing with a one-piece tooled base assembly to decrease the number of elements to be cleaned, the amount of wasted product, cleaning time, and surface area for contaminants. The filter housing is preferably adapted to use CIP cleaning technology for effective, safe and efficient cleaning of the interior portions of the filter housing.

[7] The filter housing preferably includes an integrated base that is machined or tooled from a single piece of material. The integrated base preferably includes a plurality of machined bores adapted to accept longitudinal filter cartridges inserted therein. The base plate preferably contains a plurality of sloped bores running from the bottom of each filter cartridge bore and extending downwards and inwards to a main central outlet manifold. The sloped nature of the bores substantially reduces or virtually eliminates the amount of wasted product and increases both the efficiency and efficacy of the cleaning process.

[8] The integrated cartridge plate may also include a recessed upper face. The upper face preferably recesses slightly downward from the outer edge of the plate to the outlet manifold (*e.g.*, a frustoconical indentation). Again, this slight slope may reduce the amount of wasted product when compared to

prior art filter housings with flat, removable cartridge plates. There may also be a channel in the upper face of the integrated base assembly that extends from the recessed portion of the face out into the top of the inlet manifold bore. When unfiltered product is drained from the dome after a product cycle, this channel preferably allows the unfiltered product to flow back into the inlet manifold for use in a future production cycle.

[9] The present invention may also be adapted for use with an automated cleaning technology such as Clean-in-Place (CIP). Preferably, there is an opening in the top of the dome (*e.g.*, a vertical access port) and a guide bore through the integrated cartridge plate which guides the tube-like CIP spray device assembly into the interior regions of the integrated filter housing. The CIP spray device assembly preferably includes tiny holes to emit and disperse cleaning media such as water, deionized water, steam, detergent, an acidic cleaning media, and/or a cleaning agent to automatically wash or sanitize the internal surfaces of the filter housing.

[10] The spray device hole pattern, number of holes and diameter of individual holes of the spray device will depend on a number of factors. For example, the volume and pressure of available water at the filter housing installation may dictate hole size and placement. Further, the internal configuration of the multi-round filter housing itself will dictate hole pattern so that all surfaces can be contacted with cleaning media.

[11] One of the novel features of the present invention is a system that provides a complete

programmed washing of a contaminated filter housing such that the system will pass a riboflavin test. While those of skill in the art will recognize that there are various protocols to perform "riboflavin testing," the essential features of such a test involve soluablizing riboflavin, coating the interior elements of a filter housing with the riboflavin solution, subjecting the filter housing to the cleaning process, disassembling the various components of the filter housing and subjecting the internal elements to ultra-violet light to detect the presence of residual riboflavin solution by its florescence. As indicated, the CIP technology of the present invention passes such a riboflavin test such that no florescence is detectable in any interior element.

[12] Because of the integrated design of the base unit (*i.e.*, the absence of a separate, removable cartridge plate), the only removed component that may have to be cleaned externally (*i.e.*, away from the site of the filter housing installation), is preferably the cartridge positioning plate. It is contemplated that certain embodiments of the present invention may include a cartridge positioning plate that can also be cleaned in place.

BRIEF DESCRIPTION OF THE DRAWINGS

[13] The features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings where:

[14] **FIG. 1** details an exploded isometric section of a typical prior art filter housing;

[15] **FIG. 2** shows a side cross-section of an integrated base assembly for use in the present invention;

[16] **FIG. 3** details an exploded isometric view of one embodiment of the present invention;

[17] **FIG. 4** is a side view of one embodiment of the present invention with a sprayer assembly inserted therein for cleaning; and

[18] **FIG. 5** is an isometric view of one embodiment of the present invention in which the dome is fully integrated with the base assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[19] **FIG. 1** depicts a typical prior art filter housing **100** including a multi-stage base assembly **105**, removable cartridge plate **110** and removable dome **115**. The base assembly **105** of the prior art filter housing **100** shown is supported by three legs **120** but can be fixed in a production line in a variety of standard configurations. A collection chamber **125** is recessed within the base assembly **105** towards the bottom of the filter housing **100**. The collection chamber **125** is generally annular with a flat lower face **130** which includes an outlet manifold **135** to allow filtered product to exit the filter housing **100**. An inlet manifold **140**, which is used to introduce an unfiltered product into the filter housing **100**, extends generally

upward from the center of the lower face **130** of the annular collection chamber **125**. The inlet manifold **140** extends upwards towards the top of the filter housing **100** and includes one or more O-ring sealing members **145** to seal the inlet manifold **140** to the removable cartridge plate **110**.

[20] The collection chamber **125** is surround by a raised wall on which a plurality of bolt assemblies **150** are located. The inside rim of the wall that surrounds the collection chamber includes a recessed annular ledge **155** that accepts insertion of an O-ring or other gasket-style sealant **160**. This O-ring **160** facilitates seal formation with a cartridge plate **110** that is placed above the collection chamber **125**. A flat, disk-shaped cartridge plate **110** includes multiple cylindrical apertures **162** bored therethrough. The central aperture **165** of the cartridge plate is a continuation of the inlet manifold **140**, which generally includes at least one and may include additional O-rings **145** between the inlet manifold **140** and the center aperture **165** of the cartridge plate **110**. A plurality of single-threaded, quarter-turn lock apertures **162** are arranged at roughly uniform intervals around the central inlet aperture **165**. A plurality of threaded filter cartridges **170** are adapted to mate into the apertures **162** of the cartridge plate **110**.

[21] The cartridge plate **110** also includes an annular ledge **172** on the outer aspect of its upward face adapted to accept an additional O-ring **174**. This second O-ring **174** facilitates seal formation between the cartridge plate **110** and the filter housing dome **115** which is placed over and around the cartridge plate **110**

(as shown in **FIG. 1**). The dome **115** houses the full extent of the filter cartridges **170**. A disk-shaped cartridge positioning plate (not shown) with circular apertures matched in number and size the plurality of filter cartridges **170**, is positioned over the top of the filter cartridges to hold them generally parallel to each other.

[22] The dome **115** extends above and forms a chamber around the filter cartridges and the cartridge positioning plate. Two lifting lugs (not shown) are located on the top exterior of the dome **115**. A circular opening **180** that allows access through the top of the filter assembly **100** is located on the superior aspect of the dome **115**. During normal processing operations, this opening may be a gauge port **180** for attachment of a standard pressure gauge. This access **180** is generally utilized by a spray device assembly for Clean-In-Place applications. In addition, a small sampling valve **182** may be located on the side of the gauge port **180**, or separate from the gauge port **180** on the exterior of the dome **115**. Two handles **184** are located approximately midway down the dome **115** to aid in the attachment and removal of the dome **115** to the filter housing base assembly **105**. Around the rim of the open end of the dome extends an annular dome flange **186** that forms a small ledge along the exterior base of the dome **115**.

[23] To assemble the prior art filter housing **100**, a first O-ring **160** is placed on the annular ledge **155** of the base assembly **105**. At least one O-ring **145** is placed on the inlet manifold **140**. The cartridge plate **110** is then seated over the top of these O-rings **145**, **160** on the base assembly **105** and inlet manifold **140**,

thereby matching the O-rings **145**, **160** to the lower ledge on the cartridge plate and the bore corresponding to the inlet manifold. Another O-ring **174** is then placed on the upper ledge **172** of the cartridge plate **110**, and the filter cartridges **170** are "attached" or twisted into apertures **162** of the cartridge plate **110**. Each of the individual filter cartridges **170** may have O-ring assemblies to form a seal between the cartridge **170** and the upper face of the cartridge plate **110** surrounding the cartridge filter bores **162**.

[24] The cartridge positioning plate is then seated over the top of the extending filter cartridges **170**, and the entire filter housing **100** is assembled by placing the dome **115** on top of the base assembly **105** over the O-ring **174** on top of the cartridge plate **110**. The bolt assemblies **150** located on the base **105** are secured around the dome flange **186** and tightened so that O-rings **174**, **160**, **145** are compressed to form a tight seal between the dome **115** and the cartridge plate **110**, and between the cartridge plate **110** and the base **105** and between the cartridge plate **110** and the inlet port **140**. Together, the base, the collection chamber **125**, the O-rings, and the cartridge plate **110** are referred to as the base assembly **105**.

[25] To begin normal operation, the sampling/vent valve **182** at the top of the dome **115** is opened, and unfiltered product is pumped through the inlet manifold **140** to the main chamber inside the dome of the filter assembly **110**. When the dome **115** is full of unfiltered product, the vent valve **182** is closed, forcing the product to flow through the walls of the vertically extending filter cartridges **170** and down the interior

portion of the filter cartridges **170**. The filtrate is collected in the collection chamber **125** at the bottom of the filter housing **100**. This filtrate may then proceed through another filter housing or a series of filter housings or further processing. Following use, filtrate collects ("pools") on the horizontal aspect of the lower face of the collection chamber **125** and unfiltered product collects on the flat upper face of the cartridge plate **110**. This prior art filter housing **100** also contains detachable parts (*e.g.*, cartridge plate **110**) and numerous crevices (*e.g.*, multiple O-rings) that may lead to the accumulation of bacteria and to corrosion.

[26] The limitations of this prior art filter housing **100** are even more pronounced when cleaning the filter housing **100** is considered. For example, to clean the prior art filter housing **100**, the operator traditionally has to shut off processing of the filtered product, open the vent valve **182** and then open the drain valve (not shown). This procedure allows the product within the housing to drain "completely." Typically, the drain valve will be adjacent to or incorporated with the outlet manifold **135**. After the product has drained out of the housing **100**, the operator loosens the bolt assemblies **150** that secure the filter housing dome **115** to the base **105**. The dome **115** may then be lifted up off of the base **105** clearing the vertically-placed filter cartridges **170** in the process. Generally, the weight of the dome **115** will require a mechanical lift device to engage the lifting lugs (not shown) to accommodate removal of the dome **115**. Because of the flat upper surface of the cartridge plate **110**, unfiltered product, which is at least wasteful and could even be harmful,

may seep from the filter housing **100** when the dome **115** is removed.

[27] The cartridge alignment plate is then lifted up and off of the cartridges **170**, and the cartridges can be removed from the cartridge plate **110**. These cartridges **170** may be disposed of and replaced with new filter cartridges for a future product run, or the filter cartridges **170** may alternatively be cleaned to be reused. The cartridge plate **110** may then be removed from the filter base assembly **105**. The O-rings are removed, visually inspected for cracks or other disrepair and re-installed or replaced. The collection chamber **125**, inlet **140** and outlet ports **135**, and the drain valve are then thoroughly washed. The dome **115** and vent valve, cartridge plate **110**, and cartridge alignment plate are brought to a cleaning station and cleaned away from the original site of the filter housing **100**.

[28] New O-rings or other gasket-based seals **145**, **160**, **174** may then be installed if needed on the inlet adapter **140** and/or the cartridge plate **110**. The cartridge plate **110** is re-installed into the base assembly **105**, and filter cartridges **170** are installed (or, in the case of reusable cartridges, re-installed) into the cartridge plate **110**. The cartridge positioning plate is then positioned at the top of the filter cartridges **170**, lowered into position and the dome **115** is once again brought over the top of the filter cartridges **170** and secured to the base assembly **105** by tightening the bolt assemblies **150**, thereby sealing the dome **115** to the base **105** with the O-rings. The operator may then close the drain valve and begin processing

filtered product into the dome **115** again. When the dome **115** is full of product, the operator closes the vent valve **182** in the top of the filter housing dome thereby forcing product through the filter cartridges **170** for collection.

[29] Certain aspects of this prior art system have been improved by incorporating a spray device assembly into the cleaning process to force cleaning media, for example, water, deionized water, steam, detergent, an acidic cleaning media, and/or a cleaning agent, into the inside of the dome **115**. This "Clean-In-Place" (CIP) system reduces the number of parts that need to be taken to a separate cleaning station to be sanitized prior to re-assembly and further processing of product. The prior art filter housing **100** of **FIG. 1** may utilize such a CIP system. For example, following the disassembly of the filter housing **100**, removal of the filter cartridges **170** and re-attachment of the dome **115** to the base **105**, a spray device assembly may be inserted through the top of the dome **115** of the filter housing **100**. This may require a special adapter in place of the removed cartridge plate. However, because the jets of fluid coming out of the spray device may not reach the underside of the cartridge plate **110** or in the crevices of the O-rings, and because the prior art cartridge plate **110** and collection chamber **125** generally include horizontal surfaces that do not facilitate complete draining, the cartridge plate **110** must be removed and cleaned separately. Further, the O-rings **145**, **160** beneath the cartridge plate **110** and the base **105** must be removed and cleaned or replaced, as appropriate.

[30] For example, paralleling the above cleaning description, once the dome **115**, the filter cartridges **100** and cartridge positioning plate are removed, the cartridge plate **110** is taken to a separate cleaning station. With the CIP system, the dome **115** would thereafter be reattached to the base assembly **105** by securing the bolts **150**. The spray device assembly would then be inserted through the hole **180** near the top of the dome **115** and the spray device tube would be connected to a water, deionized water, steam, detergent, an acidic cleaning media, and/or a cleaning agent. This system may then sanitize the remaining interior portions of the filter housing **100**, but may not completely drain from the horizontal surfaces of all interior places. After CIP, the cleaned cartridge plate **110**, new cartridge filters **170**, and new O-rings are preferably installed.

[31] In its broadest aspect, the present invention addresses some or all of the limitations found in the prior art by integrating the cartridge plate into the base assembly. This may reduce the number of O-ring joints, and therefore simplifies and intensifies the cleaning process. Such an integrated filter housing unit may contain sloped inner bores which allow product to flow without pooling and may be especially suited for a Clean-In-Place system.

[32] **FIG. 2** depicts a side cross-section of a base assembly **205** for use with an integrated filter housing **200**, and **FIG. 3** depicts one presently preferred embodiment of an integrated filter housing **200** utilizing said specialized base assembly **205**. The complexity of the base assembly is dramatically reduced compared to

prior art. For example, by eliminating the collection chamber, the thickness of the base may be reduced. The base assembly **205** of the filter housing **200** may be supported by a plurality of legs or any standard support structure now known or later developed **210**.

[33] With reference to **FIGS. 2** and **3**, the base **205** may include an integrated cartridge plate **212** with a recessed upper face **214**, preferably recessed toward an outlet manifold of the upper face. For example, this recession may be in the shape of an upside-down truncated cone known as a frustoconical indentation or impression. As such, the upper face recess **214** may be shaped as a frustoconical indentation that terminates at a point that is not in the center of the upper face **214**. The integrated cartridge plate **212** upper face is preferably circular with cylindrical apertures bored therethrough, arranged as a central aperture **218** with additional apertures extending radially outward at equal intervals around the central aperture **218**. The central aperture **218** and preferably all but one of the other apertures **220** are dimensioned such that filter cartridges **222** may be matingly accepted by the integrated cartridge plate **212**.

[34] One of the non-central apertures **224** is preferably not dimensioned to accept a cartridge. This non-threaded aperture **224** serves as the inlet manifold for introduction of solution into the main interior chamber of the filter housing assembly **200**. Because the inlet manifold **224** is integral to the base, at least one O-ring may be eliminated in this embodiment. The upper face of the integrated cartridge plate preferably includes a drainage channel **226** etched therein such that

unfiltered product drains toward the inlet manifold bore **224**. Therefore, when the operator shuts off the incoming unfiltered product, the portions of the product which do not drain down the outlet manifold **218** may drain back into the inlet manifold **224**, rather than being "wasted" by pooling at the surface of integrated cartridge plate **212**.

[35] The integrated cartridge plate **212**, into which the filter cartridges **222** are inserted, may also be specially machined such that the area around the outlet bore **218** is recessed or depressed **214**. Because the outlet bore **218** is at a lower height than the outer portions of the upper face of the integrated cartridge plate **212**, when the process is shut off, unfiltered product will preferably run down towards this outlet bore **218**. This recession **214** preferably enables unfiltered product to be back-drained to the inlet manifold, and may allow the CIP system to work more effectively. When the filtering system is shut off, this recession **214** also acts to collect unfiltered product and direct it through the etched channel **226** down the inlet manifold **224** for reuse. The recession may take the shape of an upside-down truncated cone, known as a frustoconical indentation or impression.

[36] With reference to **FIG. 2**, the interior portions of the integrated base assembly **205** are shown in cross-section. As seen in the example of **FIG. 2**, the outlet port **218** extends down through the center of the integrated base assembly **205**, and the inlet port **224** extends vertically through an outer portion of the base assembly **205**. It will be recognized that both the outlet port and the inlet port may be located in a

variety of positions, dependant only upon the number of cartridge ports and the demands of the cleaning process. There is also a plurality of sloped bores **230** extending from the lower portion of each cartridge filter bore **220** down to the central outlet port bore **218**. This sloped orientation allows filtered product to flow through the cartridge filter bores **220** to the outlet manifold **218** without pooling (as opposed to the prior art).

[37] It is noted that the improved design of the present invention has eliminated the need for a collection chamber. This may be a significant improvement over the prior art in that any pooling of residual filtrate on the lower face of the collection chamber is avoided. This improvement also reduces the number of components in the filter housing **200** because the detached cartridge plate of the prior art is wholly eliminated. It is further noted that the number of O-rings that are employed in the assembly of the filter housing is reduced. For example, there is no O-ring between the base and the cartridge plate in this embodiment because the base and cartridge plate are an integrated, single structure **205**, thus reducing the likelihood of seal failure. Additional advantages over the prior art may include the elimination of the O-ring or O-rings between the inlet port **224** and the cartridge plate **212**, and the adaptability of the present invention to a Clean-In-Place process.

[38] The top of the base assembly **205** preferably includes an annular recess **242** on the inner aspect of its upper face that accepts a corresponding annular ledge (not shown) of the dome. This annular ledge of the dome contains the O-ring **244** which seals the dome to

the base. The raised annulus surrounding the integrated cartridge plate possesses several threaded holes **250** that are spaced at regular intervals. During filter housing **200** assembly, bolts are threaded into these holes **250** in order to secure the dome **240** to the base assembly **205**. In addition, pins **252** are placed at regular intervals extending vertically from the base assembly **205**. These pins **252** guide the operator in mating the dome **240** to the base assembly **205** and may stabilize the interaction between the base assembly **205** and the dome **240** during filter housing **200** assembly and disassembly. The base **205** of the filter housing **200** is preferably a single machined piece of metal thus reducing the overall number of separate parts contained in the filter housing **200**.

[39] The filter housings of the present invention are preferably constructed of nonferrous metal, such as stainless steel, but may also be composed of other nonferrous metals such as Iconel, Hastelloy, and alloys such as AL-6XN™. Further, it may also be possible to practice various embodiments of the present invention by employing high-density, nonporous plastics. Depending on the specific filter process requirements, it may also be desirable to form the various elements of the filter housing from heterologus materials (*e.g.*, base made of stainless steel coupled to a dome of high-density plastic).

[40] The dome **240** is removably connected to the base **205**. For example, the dome **240** may be secured to the base **205** by a tension clamp, threaded engagement, magnetism or any other means that allows separation of the dome **240** from the base **205**.

[41] The dome **240** extends vertically and forms a chamber around the filter cartridges **222** and the disk-shaped cartridge positioning plate **260**. A valve **266** is preferably located on the superior aspect of the dome that may be used to vent air during filling of the dome or alternatively, for sampling of product during processing. An opening **262** that allows access to the top of the filter assembly **200** is located on the superior aspect of the dome **240**. In certain applications, this opening **262** may also serve as a gauge port during the filtration process. This opening **262** is aligned such that a spray device assembly for Clean-In-Place applications may be inserted to traverse the interior of the dome **240** and terminate within the outlet port **218** of the base **205**. It is contemplated that either opening **262** and/or outlet port **218** may be located somewhere other than at their respective centers. Preferably, the spray device assembly will terminate at a point that facilitates the distribution of cleaning solution to all interior elements and surfaces of the dome **240** and base assembly **205**, including direct contact with the sloped cartridge filter bores **230**. Two handles **270** are located approximately halfway down the dome **240** to aid in the placement and removal of the dome **240** to the filter housing base assembly **205**. At the rim of the open end of the dome **240** there is wide-lipped flange **272** that is removably connected to the base flange. For example, it may posses threaded **274** and non-threaded **276** holes at regular intervals. Bolts can be inserted through the threaded holes **274** and are used to secure the dome **240** to the base assembly **205** during filter housing **200** assembly. Pins **252** from the base assembly **205** may be arranged to be inserted into the wide-lipped flange **272** on the dome **240** and aid in the alignment of

the threaded holes **274** in the wide-lipped flange **272** to the threaded holes **250** in the base assembly **205**.

[42] During normal operation, unfiltered product is pumped into the dome **240** via the inlet manifold **224**. While the dome **240** is being filled, air is allowed to escape via the valve **266** (opened) that is located on the superior aspect of the dome **240**. After the dome **240** is filled, the valve **266** is closed, thus forcing unfiltered product into and down through the filter cartridges **222**. Filtrate (filtered product) travels down the interior portions of the cartridge filters **222**, through the sloped bores **230** that connect the cartridge filter bores **220** to the outlet manifold, and out of the filter housing **200** for collection.

[43] When the filtering process is over, unfiltered product is no longer pumped into the dome **240**. Instead, the vent valve **266** is opened and unfiltered product is drained from the dome **240** back through the inlet manifold **224** (preferably to be re-used in a future filtering process). The etched drain channel **226** of the cartridge plate **212** is such that unfiltered product drains toward the inlet manifold **224**. A slope in the channel **226** (best shown in **FIG. 2**) toward the inlet manifold **224** allows the solution to drain into the inlet manifold **224**. Having sloped openings in the base **205** to seat the disposable media **222** (cartridges) versus a separate cartridge plate and flat base eliminates waste of product due to pooling of product during process or accumulation of cleansing medium during cleaning.

[44] **FIG. 4.** depicts one presently preferred method of cleaning the integrated filter housing using

Clean-In-Place technology. The dome **410** is removed from the filter assembly **400** by removing the bolts that secure the dome **410** to the base assembly **405**. The positioning plate is removed from the filter cartridges, and the cartridges themselves are removed from the filter housing (to be cleaned or replaced). The dome is then re-attached. A spray device assembly **415**, including, for example, a tubular element **417** incorporating various spray device elements may be inserted through the access opening (*e.g.*, gauge port) at the top of the dome **410**. The spray device tube **417** is preferably connected to a source of water, steam, or other cleaning fluid, the selection of which will be determined by the filtering process and system requirements. The spray device tube **417** is preferably adapted to extend vertically down into the outlet manifold bore **422** to an extent at least as low as the point where the sloped cartridge filter bores **424** meet the central outlet manifold bore **426** (**FIG. 4**). This orientation allows all aspects (*i.e.*, surfaces and elements) of the integrated base assembly **405** to be cleaned using CIP technology, rather than just certain aspects of the interior of the dome **410**.

[45] At least one embodiment of the present invention is much more easily cleaned in place compared to the prior art. There is no removable cartridge plate to be cleaned externally. The inserted spray device is able to access all areas of the dome that are exposed to unfiltered product as well as all areas of the base assembly that are in contact with both unfiltered and filtered product (filtrate). The one-piece construction of the base and the sloped cartridge bores in the base greatly reduce the number of areas where solution and

bacteria can accumulate thus reducing the likelihood of bacterial contamination and corrosion (*e.g.*, no horizontal surfaces and fewer O-ring joints). Also, the sloped bores and beveled upper face of the integrated cartridge plate allow better, more complete draining of both product and cleaning solution during the CIP process.

[46] **FIG. 5.** displays an alternative presently preferred embodiment of an integrated filter housing **500** wherein the walls of the dome **510** are integrated with the base assembly **505** into one piece. The internal structure of the base assembly **505** in this embodiment of the present invention is preferably similar to that depicted in **FIGS. 2** and **3**. The design displayed in **FIG. 5** decreases the number of individualized parts which must be separately cleaned compared to the prior art (*e.g.*, no separate cartridge plate). In addition, there is no O-ring at the bottom of the filter assembly **500** (*i.e.*, between the dome and the integral base) that may collect bacteria because it has now been moved to the top of the filter housing **500** between the upper dome flange **525** and dome cap flange **530**. The replacement of filter cartridges and the cleaning of the interior of the filter housing may be greatly simplified in this embodiment of the present invention. To clean the interior of the filter housing **500** or remove filter cartridges, the operator preferably removes the dome cap **535** of the filter housing **500**. The user does not have to lift the entire dome off of the base and over the cartridge. In this embodiment, the total weight of the filter housing portion that has be to removed **535** for cleaning and cartridge replacement is greatly reduced. In fact, in certain embodiments, a mechanical lifting

device may not be necessary due to the greatly reduced size and weight of the portion being removed. Further, the vertical clearance required to utilize this embodiment in a production installation is proportionately reduced.

[47] Currently, users must go through a time consuming manual disassembly procedure to thoroughly clean sanitary multiround filter housings. One step in the cleaning process is to remove the cartridge plate and clean it at some location which is usually located a distance away from where a filter housing is customarily installed in a process system. This step is preferably eliminated in the present invention. A filter housing may still have to be disassembled to change the disposable media (cartridges). However, process downtime due to cleaning is preferably reduced because there is no separate cartridge plate that needs to be removed and cleaned independently of flushing the remaining components of the filter housing. Rather, the entire filter housing assembly can be cleaned-in-place. Further, certain embodiments of the present invention may reduce operator fatigue due to the simplification of the cleaning process and the decreased weight to be lifted during disassembly and cleaning.

[48] While specific embodiments and methods for practicing this invention have been described in detail, those skilled in the art will recognize various manifestations and details that could be developed in light of the overall teachings herein. Accordingly, the particular arrangements disclosed are meant to be illustrative only.